

PATENT
112025-0179/1614**CLAIMS**

- 1 1. A hierarchical memory structure for use in matching a data string having a plu-
2 rality of fields, the associative memory structure comprising:
3 a top-level associative memory; and
4 at least one next-level associative memory operably coupled to the top-level asso-
5 ciative memory so as to receive an output therefrom, wherein
6 the top-level associative memory is configured to receive and match one
7 or more of the fields of the data string and, in response to detecting a match, pro-
8 viding an output to the next-level associative memory, and
9 the at least one next-level associative memory is configured to receive and
10 match the output from the top-level associative memory plus one or more other
11 fields of the data string or one or more values derived therefrom and, in response
12 to detecting a match, outputting a result.
- 1 2. The hierarchical memory structure of claim 1 wherein the data strings being
2 matched are network messages.
- 1 3. The hierarchical memory structure of claim 2 wherein the one or more fields
2 input to the top-level associative memory include an Internet Protocol (IP) address field.
- 1 4. The hierarchical memory structure of claim 1 wherein the top-level associative
2 memory and next-level associative memory are each ternary content addressable memo-
3 ries (TCAMs) that support don't care values.
- 1 5. The hierarchical memory structure of claim 4 wherein the data strings being
2 matched are network messages.

09613039-071000

1 6. The hierarchical memory structure of claim 5 wherein the one or more fields
2 input to the top-level associative memory include an Internet Protocol (IP) address field.

1 ~~8~~ 7. The hierarchical memory structure of claim 1 wherein the output of the top-
2 level associative memory that is received by the at least one next-level associative mem-
3 ory has a length that is shorter than a length of the one or more fields of the data string
4 that are input into the top-level associative memory.

1 ~~9~~ ⁸ 8. The hierarchical memory structure of claim ~~7~~ wherein the length of the output
2 of the top-level associative memory is on the order of one-fourth or less of the length of
3 the one or more fields of the data string that are input into the top-level associative mem-
4 ory.

1 ~~10~~ ⁹ 9. The hierarchical memory structure of claim ~~8~~ further comprising a first mem-
2 ory structure associated with the top-level associative memory, the top-level associative
3 memory and first memory structure configured such that, in response to detecting a match
4 to an entry in the top-level associative memory, the top-level associative memory speci-
5 fies a location of the first memory structure containing the output that is provided to the
6 at least one next level associative memory.

1 ~~11~~ ¹⁰ 10. The hierarchical memory structure of claim ~~9~~ further comprising a message
2 buffer for temporarily storing the data string, and buffer control logic for providing se-
3 lected fields from the message buffer to the top-level and next-level associative memo-
4 ries.

1 ~~12~~ ¹¹ 11. The hierarchical memory structure of claim 1 further comprising:

1 7/16. The hierarchical memory structure of claim 4 further comprising a plurality of
2 records organized into common fields, wherein

3 at least one field of each record, which originally contained a corresponding
4 value, is replaced with a unique coordinate value (UCV) that has been generated for the
5 corresponding value, and

6 each UCV is shorter than the corresponding value that it replaces.

1 17. The hierarchical memory structure of claim 1 further comprising a plurality of
2 records organized into common fields, wherein

3 at least one field of each record, which originally contained a corresponding
4 value, is replaced with a unique coordinate value (UCV) that has been generated for the
5 corresponding value, and

6 each UCV is shorter than the corresponding value that it replaces.

1 18. A method for loading a hierarchical, associative memory structure with a plu-
2 rality of records, each record organized into common fields having values and/or don't
3 cares, so that a data string, also having a plurality of fields, may be compared with the
4 contents of the memory structure in order to identify a matching record, the method com-
5 prising the steps of:

6 identifying the coordinate sub-fields of at least one selected field of the records,
7 the selected field having distinct values or don't cares;

8 determining the number of distinct values that each coordinate sub-field has;

9 for each coordinate sub-field, computing the minimum number of bits needed to
10 individually represent each of the distinct values and don't care, if present, for the re-
11 spective coordinate sub-field;

12 assigning a unique coordinate value (UCV), that falls within the previously com-
13 puted minimum number of bits, for each distinct value and don't care, if present;

17 loading the hierarchical, associative memory structure with the generated UCVSSs.

1 21. The method of claim 20 wherein the selected field corresponds to an Internet
2 Protocol (IP) address field.

22. An apparatus for loading a hierarchical, associative memory structure with a plurality of records, each record organized into common fields having values and/or don't cares, so that a data string, also having a plurality of fields, may be compared with the contents of the memory structure in order to identify a matching record, the method comprising the steps of:

6 means for identifying the coordinate sub-fields of at least one selected field of the
7 records, the selected field having distinct values or don't cares;

8 means for determining the number of distinct values that each coordinate sub-
9 field has;

10 for each coordinate sub-field, means for computing the minimum number of bits
11 needed to individually represent each of the distinct values and don't care, if present, for
12 the respective coordinate sub-field;

13 means for assigning a unique coordinate value (UCV), that falls within the previ-
14 ously computed minimum number of bits, for each distinct value and don't care, if pres-
15 ent;

16 for each record, means for generating a unique coordinate value sequence
17 (UCVS) by concatenating the UCVs assigned to the distinct values and don't care, if pre-
18 sent, of the respective record; and

19 means for loading the hierarchical, associative memory structure with the gener-
20 ated UCVSs.

1 23. A computer readable medium containing executable program instructions for
2 loading a hierarchical, associative memory structure with a plurality of records, each rec-
3 ord organized into common fields having values and/or don't cares, so that a data string,
4 also having a plurality of fields, may be compared with the contents of the memory
5 structure in order to identify a matching record, the executable program instructions
6 comprising steps for:

7 identifying the coordinate sub-fields of at least one selected field of the records,
8 the selected field having distinct values or don't cares;

9 determining the number of distinct values that each coordinate sub-field has;

10 for each coordinate sub-field, computing the minimum number of bits needed to
11 individually represent each of the distinct values and don't care, if present, for the re-
12 spective coordinate sub-field;

13 assigning a unique coordinate value (UCV), that falls within the previously com-
14 puted minimum number of bits, for each distinct value and don't care, if present;

15 for each record, generating a unique coordinate value sequence (UCVS) by con-
16 catenating the UCVs assigned to the distinct values and don't care, if present, of the re-
17 spective record; and

18 loading the hierarchical, associative memory structure with the generated UCVSs.

05613039-074000